

We Claim

Claims

1. A material dispensing device, comprising an elongated cantilever comprising a plurality of thin films arranged relative to one another to define a microchannel in the cantilever, said cantilever having a material dispensing tip proximate an end of the cantilever and communicated to the microchannel to receive material therefrom.
2. The device of claim 1 wherein the microchannel is defined between a pair of thin films that in part form a body of the cantilever.
3. The device of claim 2 further including a sealing layer disposed on one of the thin films and overlying outermost edges of the thin films.
4. The device of claim 3 wherein the outermost edges of the thin films include an angled region extending from a respective planar film region and wherein the sealing layer fills any gap between the thin films at the angled regions.
5. The device of claim 4 wherein one of the thin films comprises dual thin film layers having different residual stress.
6. The device of claim 2 wherein the microchannel is communicated to a material-containing reservoir that supplies material to the microchannel.
7. The device of claim 5 wherein the reservoir is provided on a semiconductor chip substrate and the cantilever extends from the chip substrate.
8. The device of claim 1 wherein the dispensing tip comprises a pointed tip body and an annular shell comprising one of the thin films spaced about the tip body to define a material dispensing annular space about the tip body.
9. The device of claim 8 wherein the tip body comprises a material more hydrophilic than the shell material.
10. The device of claim 8 wherein a substrate or a first thin film defines the tip body and a third thin film defines the shell about the tip body.
11. The device of claim 1 wherein one of the thin films is connected to a semiconductor chip substrate.

12. The device of claim 1 wherein the microchannel has a width dimension in the range of about 4 to about 10 microns and a height dimension in the range of about 0.05 to about 1.5 microns.
13. The device of claim 8 wherein the tip has an apex and a height of about 3 to about 5 microns of the tip relative to a plane of the cantilever.
14. The device of claim 1 wherein the cantilever has a length of about 100 to about 500 microns measured from an edge of a chip substrate.
15. The device of claim 1 wherein the microchannel comprises first and second side-by-side channel regions separated by a wall wherein the channel regions terminate in a common arcuate channel region extending partially about the dispensing tip.
16. The device of claim 1 including an actuator on the cantilever to impart bending motion thereto.
17. The device of claim 16 wherein the actuator is selected from one of a piezoelectric actuator, thermal actuator, and a magnetic actuator.
18. The device of claim 1 that includes a plurality of said cantilevers integrated in linear or two dimensional arrays or in stacks of two dimensional arrays to form a three dimensional array.
19. A material dispensing device, comprising a material dispensing tip having a pointed tip body and an annular shell spaced about the tip body to define a material- dispensing annular space about the tip body.
20. The device of claim 19 wherein the tip body comprises a material more hydrophilic than the shell material.
21. The device of claim 19 wherein a substrate or a first thin film defines the tip body and a third thin film defines the shell.
22. The device of claim 19 that includes a plurality of said cantilevers integrated in linear or two dimensional arrays or in stacks of two dimensional arrays to form a three dimensional array.

23. A method of making a material dispensing device, comprising forming on a substrate a plurality of thin films arranged relative to one another to define an elongated cantilever precursor having a microchannel extending at least partly along the length of the cantilever precursor, forming a material dispensing tip proximate an end of the cantilever precursor and communicated to the microchannel, and releasing a portion of the cantilever precursor from the substrate to form a cantilever extending from the substrate, said cantilever having the microchannel and dispensing tip thereon.
24. The method of claim 23 including forming the microchannel between a pair of thin films deposited on the substrate.
25. The method of claim 24 including depositing a sealing layer on one of the thin films so as to overlie outermost edges thereof and seal any gap between the outermost edges.
26. The method of claim 25 including forming an angled region extending from respective planar film region of each of the pair of thin films and depositing the sealing layer partially between the pair of thin films at the angled regions.
27. The method of claim 26 including forming one of the pair of thin films as dual thin films having different residual stress.
28. The method of claim 23 including forming a fluid reservoir on the substrate communicated to the microchannel.
29. The method of claim 28 wherein the reservoir is provided on a semiconductor chip substrate and the cantilever extends from the chip substrate.
30. The method of claim 23 including forming the dispensing tip to include a pointed tip body and an annular thin film shell spaced about the tip body to define a fluid dispensing annulus about the tip body.
31. The method of claim 30 wherein the tip body is formed of a material more hydrophilic than the shell material.
32. The method of claim 24 wherein the microchannel is formed with a width dimension in the range of about 4 to about 10 microns and a height dimension in the range of about 0.05 to about 1.5 microns.

33. The method of claim 31 wherein the tip body has an apex and a height of about 0.1 to about 1.5 microns of the tip relative to a plane define by an end of the shell.
34. The method of claim 23 wherein the cantilever has a length of about 100 to about 1000 microns measured from an edge of a chip substrate.
35. The method of claim 23 including forming first and second side- by-side channel regions separated by a wall wherein the channel regions terminate in a common arcuate channel region extending partially about the dispensing tip.
36. The method of claim 23 including forming said plurality of said thin films on said substrate to form a plurality of said cantilevers integrated in linear or two dimensional arrays or in stacks of two dimensional arrays to form a three dimensional array.
37. A method of making a microchannel, comprising depositing first, second and third thin films on a substrate, removing an outermost edge region of the second thin film to form an open sided microchannel between the first and third thin films, and sealing the outermost edge region of the open side of the microchannel by depositing a fourth thin film on one of the first and third thin films so as to overlie the outermost edge region of the open side.
38. The method of claim 37 including angling the outermost edge regions of the first thin film before depositing the sealing layer.
39. The method of claim 38 wherein one or both of the first and third thin films comprises dual thin films having different residual stress to impart said angling thereto.
40. A method of making a microtip, comprising forming a pointed tip on a substrate, depositing first, second and third thin films on the pointed tip on the substrate, removing a region of the second thin film and the third thin film about the tip to form an annular space between the first and third thin films, and removing the substrate such that the first thin film defines the microtip.
41. The method of claim 40 including continuing to selectively remove the second thin film about the tip until the annular space communicates to a microchannel.
42. The method of claim 40 wherein the tip is implanted with an etch stop dopant prior to deposition of the first, second, and third thin films.

43. The method of claim 40 including forming a microchannel that communicates with the annular space to supply fluid thereto.
44. The method of claim 39 including forming a fluid reservoir that communicates with the microchannel to supply fluid thereto.
45. The method of claim 39 including forming said plurality of said thin films on said substrate to form a plurality of said microtips on a plurality of cantilevers that are integrated in linear or two dimensional arrays or in stacks of two dimensional arrays to form a three dimensional array.
46. A method of forming a nanopattern, comprising supplying writing material through a microchannel in a cantilever extending from a substrate to a material dispensing tip proximate an end of the cantilever and moving the dispensing tip close enough to a surface to dispense the writing material thereon.
47. The method of claim 46 including supplying writing material from a microreservoir on the substrate to the microchannel and then to the dispensing tip by capillary action.
48. The method of claim 47 wherein the writing material is dispensed through an annulus formed between a pointed tip body and an annular shell spaced about the tip body.
49. The method of claim 46 including moving the cantilever by imparting a bend to it.
50. The method of claim 49 wherein the bend is imparted by energizing a piezoelectric film, a thin film thermal actuator or magnetic film on the cantilever.
51. The method of claim 46 wherein said writing material is supplied to a plurality dispensing tips residing on respective cantilevers integrated in linear or two dimensional arrays or in stacks of two dimensional arrays to form a three dimensional array.
52. The method of claim 51 wherein each of the cantilevers is addressed and actuated independently.
53. A method of scanning probe microscopy of a surface, comprising providing a cantilever extending from a substrate and having a volcano-shaped microtip proximate an end of the cantilever and moving the cantilever to have the microtip probe the surface.

54. A method of applying an electrical stimulus and measuring the electrical response of a surface in nanometer-scale vicinity of a probing tip in the presence of a locally created environment at the end of the tip through material dispensed around that tip, comprising providing a cantilever extending from a substrate and having a volcano-shaped microtip through which a material creating the local environment is dispensed proximate an end of the cantilever and moving the cantilever to have the microtip provide an electrical stimulus or to record an electrical response at a given location on the surface.
55. The method of claim 54 wherein the stimulus is applied and/or recorded at the given location to characterize one of the surface and the dispensed material.
56. A material dispensing device, comprising an elongated cantilever comprising first, second, and third thin films arranged relative to one another to define a microchannel in the cantilever and a material dispensing tip proximate an end of the cantilever, said material dispensing tip being defined between a pointed tip body on a substrate and the third thin film.
57. The device of claim 56 including a reservoir for the material on the substrate, said reservoir communicating to the microchannel.
58. A method of making a material dispensing tip, comprising forming a pointed tip on a substrate, locally ion implanting the pointed tip with an etch stop, depositing a first thin film on the substrate including on the ion implanted pointed tip, locally removing the first layer around the ion implanted pointed tip, depositing second and third films on the substrate including on the ion implanted pointed tip, removing regions of the third and second films about the ion implanted pointed tip to form a material dispensing annular disposed between the pointed tip and the third film and extending about the ion implanted pointed tip.